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Rail Crack Detection Vehicle (RCDV)

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Abstract – The detection of critical inherent cracks in the railhead is a major challenge for the railway industry. Conventional inspection methods have proven not to be reliable enough in this context; therefore the aim of this project is to develop an alternative screening method. The designed robot will be used for analysis of railway tracks for various parameters and which will act as an assistance to manual checking process to ensure the safety of the track. The primary idea is to take benefit from rocker bogie rover mechanism and further modify it to what we call the RAIL CRACK DETECTION VEHICLE. The robot goals include automated inspection of railway track and also we can have an additional attachment to the robot can be used for cleaning of the track simultaneously with the checking. The robot has ability to enter and leave the track as the rover arrangement can overcome various obstacles like rails, sleepers, and track foundation. The mechanism enables the robot to travels through uneven surfaces and it can withstand worst terrain conditions. Robot has six wheel arrangements for driving the robot on other than track conditions and the other is roller arrangement for driving the robot on the track. To check the track robot will enter inside the track and then it will use the lifting mechanism so the rollers gets on the rail and six wheels gets elevated from the ground. By using its four rollers robot will move on the track in same manner like a train as the width of the roller system is equal to width of the track. As it is using the track for its forward movement hence it will have direction stability while checking and can be easily operated in automatic mode. Robot can be used between time interval of two trains when the track is empty and it will start inspection process and it will leave the track before next train arrives by real time commands depending on the location and the velocity of the train. We can control the robot for required checking and cleaning operation of the track via various interfaces and also with some onboard sensors. When robot is on the track, it is in automatic mode and when it is outside the track, operator assistance may require. It will reduce the work load on inspection team as there is no human interference on the track while inspection, so it will also ensure the safety of inspection team which is usually on the track while manual inspection. The main objective of the robot is to assist the manual checking system as it is risky and time consuming. Heavy traffic leads to more frequent inspection and maintenance of the track and RCDV will accomplish it in considerably less time.The project aims to design, fabricate and validate innovative re-configurable mobile robots that can be adapted to various inspection tasks in routine railway inspections.

Key Points -

1. Automation in the inspection process.

2. No manual interference.

3. Design allows the robot to automatically enter and work on the track and also for leaving the track when inspection is completed.

4. The time when the track is empty between the interval of two trains is utilised for the inspection as the design helps for that.

I. INTRODUCTION

Rail inspection is the practice of examining rail tracks for flaws that could lead to catastrophic failures. According Safety Analysis, track defects are the second leading cause of accidents on railways. The leading cause of railway accidents is attributed to human error. The contribution of poor management decisions to rail accidents caused by infrequent or inadequate rail inspection. In Indian Railways, flaw detection by ultrasonic is carried out with the help of two different types of equipments viz. Single rail tester and double rail tester. The single rail tester has been utilised on Indian Railways for over 40 years and the double rail tester is of a relatively recent origin (developed Ten years back). In addition hand testers of some designs are also being used. Continuous testing of rails by manual flaw detectors is strenuous and demands continuous concentration on CRT screen, also the speed achievable is only 2/6 track km in a day. An equipment which can shortlist likely defective spots quickly can improve the effectiveness of the testing. Self Propelled Ultrasonic Rail Testing (SPURT) Car has been procured for this purpose and is in operation since May'88 over Indian Railways. This car tests both the rails while

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travelling up to 30 km/h. Most of the testing operations have been automated in this car.The Indian Railways currently uses Self Propelled Ultrasonic Rail Testing (SPURT) cars for detecting cracks. But the problem with the car is the car is large and cannot give way to a train and for its operation mega blocks are required to announce.

II. CURRENT INSPECTION SYSTEM

Generally following methods are used for the inspection of the tracks -

1. USFD Method

A) *Single rail tester*

SRT is used for the inspection of the single rail at a time. It is manually operated and needs more time for the inspection.

B) Double Rail tester

The double rail tester is capable of testing both the rails at a time. This equipment, unlike the single rail tester, has multichannel facility i.e. the signal received from each probe can be instantaneously distinguished without taking recourse to process of elimination. This equipment has also been provided with a threshold arrangement, LED display and audio alarm in addition to the CRT screen. Thus there are three modes of defect indication i.e., CRT, audio alarm and LED display. DRT is also manual and it cannot give way to a train as, itself DRT uses the track for its locomotion.

2. SPURT CAR

SPURT car tests at higher speed, observations for flaws can not be done manually. Identification of defects is done electronically according to laid down logics. Also it has computer for tabulating, printing and storage of data.

The car, equipped with automatic computerized system, is capable of detecting, analyzing, locating various rail defects. it gives report of detected defects in a desired format

This spurt car can detect most rail defects that normally develop under traffic during service. the type of defect, its size, and its position in the rail section is automatically determined. the spurt car is able to screen the rail section completely in the web and almost completely in the head and the zone of the foot below the web. the flange of the foot and the top corners of the head, however, are not screened. the defects recorded are automatically analyzed. The results are given in a synthesized form in a prescribed manner.

The problem with spurt car is the operating frequency is less and train transportation needs to be stop for its operation.

III. PROBLEM DEFINATION

With increased rail traffic carrying heavier loads at higher speeds, a quicker more efficient way of inspecting railways is needed, as manual checking is time consuming and risky and limitation with the use of SPRUT car.

PROJECT OVERVIEW

The effort is aimed at producing better and faster methods for detecting internal rail and joint bar defects and developing automated methods for better and more consistent interpretation of rail defect measurement data. This project will assess the application of new technologies other than those normally used for the detection of rail flaws. Integration of robotics and smart communication technologies presents opportunities to develop rail into a more commercially sustainable industry. One of the important rail infrastructure management activities involves regular inspection of track conditions, which is labor intensive and could be potentially augmented with robotics.

IV. LITERATURE SURVEY

1. Study Methodology

Railway system uses various methods for crack detection in rail tracks for example Ultra Sonic method (Mostly used) and it is manual method, Eddy current method, Radiographic Testing, Electromagnetic Acoustic Transducer, etc. Which are onboard on SRT, DRT and SPURT car. But these medias on which the inspection methods are based are having certain drawbacks like they are manual, inspection frequency is less and more time is required for inspection.

Most likely used method is ultrasonic rail testing method but as this method is manual it takes time check the track also there are chances of human error in checking, the lives of workers on the track while checking is also in danger since if a train comes there might not be enough time to leave the track.

In order to save time required for checking of the track, to avoid the risk of life of workers and to avoid mega blocks and such, this project is constructed.

2. Literature Survey

In order to find out what the inspection department of Indian railway I visited nearest railway station, and following are the methods which are in current use.

a) The Indian Railways currently uses Self Propelled Ultrasonic Rail Testing (SPURT) cars for detecting cracks. The car is large and cannot give way to a train.

b) Other manual method –

USFD Method- A) Single rail tester

B) Double Rail tester

They mentioned the following demerits of current crack detection system -

- Considerable amount of time is required to check for cracks.

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- Chances of human error are high which can lead to accidents.
- It is not possible to check the track between the time gap of two train.
- The life of workers is at risk in case a train comes while checking it is difficult for them to move away from track in time.
- While the track is being checked the trains are either delayed or stop until checking is done.

I also checked the website of railway ministry to find out the schedule of rail checking and for more information about the improvements required in current rail inspection system. and also checked inspection methods used by foreign countries for crack detection and compared them to ours.

Before proceeding to start our project; searched for the robots which were already available but all of them were unable to enter and leave the track without any human contact hence they were unable to check the track between the time gap of two trains, which is a big demerit, to make the robot enter and leave the track on its own; the rocker bogie mechanism of NASA is used.

3. Literature Review

I have search outcome for the current robots developed for the same purpose but they have certain major drawbacks.

About Current Robots –

- These robots cannot be used on running tracks as it uses track for its own purpose.
- Robots can't enter or leave the track on their own, manual help is required for placing of these robots.
- Current robots are less feasible for practical use.
- This drawbacks are eliminated in the Rail Crack Detection Vehicle.

From all the all the information got from railway department and all the information about current robots and foreign inspection method we gathered from internet, I found it necessary to build a robot which could check the track automatically and more efficiently in most economical way, due to its mechanism it can check the track between the time gap of two trains. This project will act as a supplementary system for track checking to the manual system.

V. SYSTEM ACHITECTURE

Used mechanisms-

The robot has the six wheel arrangement for driving the robot in other than track conditions and the other is roller arrangement for driving the robot on the track. Which is integrated with the rocker bogie with the help of lifting mechanism.

1. Rocker Bogie Mechanism

The **rocker-bogie** system is the suspension arrangement used in the Mars rovers (mechanical robot) introduced for the Mars Pathfinder and also used on the Mars Exploration Rover (MER) and Mars Science Laboratory (MSL) missions. It is currently NASA's favored design.

The term "rocker" comes from the rocking aspect of the larger links on each side of the suspension system. These rockers are connected to each other and the vehicle chassis through a differential. Relative to the chassis, when one rocker goes up, the other goes down. The chassis maintains the average pitch angle of both rockers. One end of a rocker is fitted with a drive wheel and the other end is pivoted to a bogie.

The term "bogie" refers to the links that have a drive wheel at each end. Bogies were commonly used as load wheels in the tracks of army tanks as idlers distributing the load over the terrain.

This mechanism enables the robot to enter and leave the track as the rover arrangement can overcome various obstacles like rails, sleepers and track foundation. The mechanism helps the robot to travel through uneven surfaces with sudden slopes and inclination

2. Modifications made with Rocker Bogie mechanism

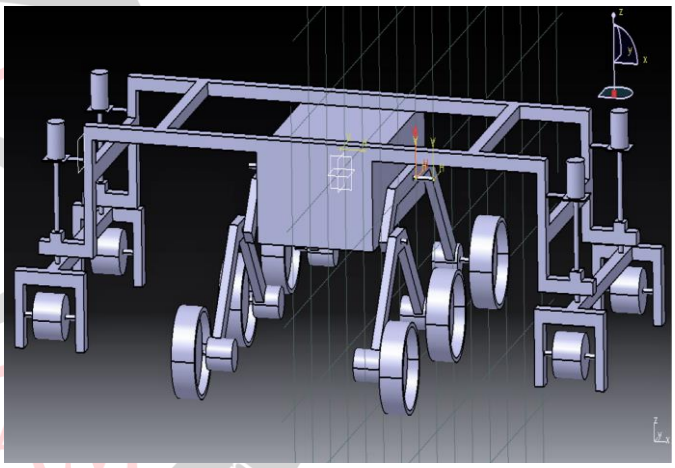

Fig a) Rocker Bogie mechanism constructed in modeling software

After entering the track in order to lift the main rover body from the ground and to bring the rollers on the rails lifting mechanism is designed.

It consists of two horizontal beams with inversion of screw jack mechanism. Four lifting mechanism are mounted at the end of two beams.

Further the ends of lead screws of screw jack mechanism are connected to the roller assembly on either sides.

Guide ways are provided for the motor allowing up and down motion but it restricts the reverse effect of rotation lead screw on the motor.

Thus lifting of the rover from track surface is achieved.

3. Roller system

Roller system is connected to the lifting mechanism. The roboat is using roller system for the movement on the track

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for its forward movement hence it will having the directional stability while Inspection.

Working -

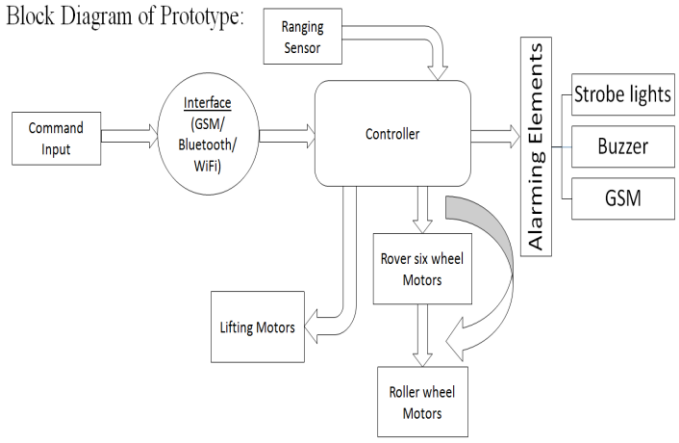

Fig. b) Block diagram of working of Rocker Bogie mechanism

Steps of operation -

1.The robot will enter inside the track by using its rocker bogie mechanism by overcoming various obstacles and it will get aligned with the track.

2. The robot will use its lifting mechanism to lift the rover from the ground by brining rollers on the track rails.

3. Then it will start checking of the track and it will be in the automatic mode.

4. As checking is supposed to be done between the time interval of two trains, the robot needs to leave the track before arrival of the next train by real time commands depending on the position of the train.

5. The robot will depart from the track by lifting up the rollers and hence rocker wheels gets on the surface.

Modification for cleaning purpose

Along with the checking of track we can use some attachments so simultaneously with checking the robot can also clean the track.

The modified design is given below –

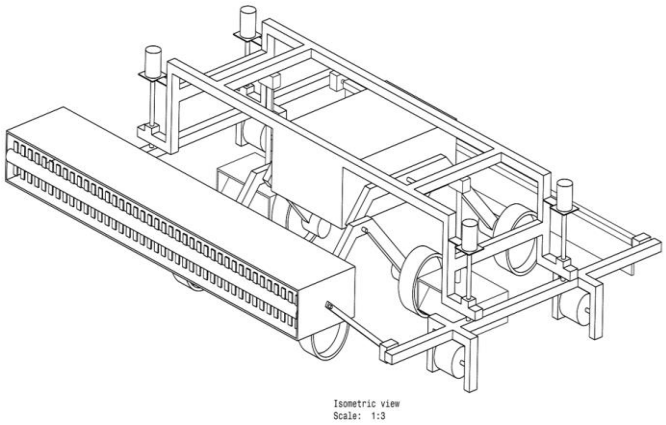

Fig. c) Modification of the Rocker Bogie mechanism

VI. RESULT

Inspection of the maximum track in minimum time as it being used between the interval of two trains.

As the process of inspection is totally automatic so there is no chance of human error.

Most efficient and accurate way of inspection as there is elimination of manual methods.

A supportive unit for today's inspection method and more importantly it will enhance the safety of rail tracks.

It will reduce the work load on inspection team.

SELIENT FEATURES

The robot has ability to enter and leave the track automatically hence eliminates the limitations of spurt car.

Checking will be done when track will be empty and robot will leave the track before the arrival of next train thus, easily can give way to a train.

The schedule of trains does not get disturbed as it is supposed to use for the duration when there is no train on the track and hence no need of announcing mega blocks or maintenance/inspection hours which affects the timetable of trains or trains needs to be cancelled.

It will be effective in urban and rural areas.

Adequate use of robotics and control technology the manual methods can be rectified to some extent and hence it will provide relief to the workers involved in the process leading to greater accuracy and reliability.

TECHNICAL ASPECTS

Atomization in the track inspection system.

To assist the current system.

To reduce the dead time in checking.

To have accuracy, precision, and reliable checking of track

VII. CONCLUSION

Our main objective is to assist the current checking system as checking tracks is risky and time consuming.

The robot will help in inspection process by practical use on the track, along with checking it will also clean the track with mechanism for cleaning attached to it, as the cleaned track is the main aspect of goof health of the system.

The fact that humans have to check and clean garbage thrown on the track, which is not safe so we have developed this robot.

As manual checking is done nowadays and there are chances of human error and these problems can be rectify by adequate use of robotics and control technologies.

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The main objective of this robot is to assist the current manual checking system, as manual process is risky and time consuming.

The robot will help to enhance the inspection process by the practical use on the tracks.

The reaches of the robot can be increased to a maximum extent while transforming it from prototype to the practical one.

With the cleaning attachment it can also clean the tracks along with the checking.

The fact that humans have to clean garbage thrown on the rails tracks which is not safe so we are having additional system to this robot. Manual cleaning is done now-a-days, owing to peculiar nature of the job, and many who are engaged for the job suffer from related health problems. The prevailing condition can be rectified to some extent by adequate use of robotics and control technology.

Along with the inspection we have made a provision which can be used to attach cleaning system for the rails which will also ensure the good health of the railway tracks.

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Project Photograph

Fig. d) Actual model of Rocker Bogie mechanism

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